power density of about 4.3 to about 10.0 watts per square inch to an anode and cathode in the chamber, a substrate surface temperature of between about 200°C to about 400°C, and a showerhead to substrate surface spacing of between about 300 to about 600 mils.

Cancel

REMARKS

This is intended as a full and complete response to the Office Action dated April 25, 2001, having a shortened statutory period for response set to expire on July 25, 2001. Claims 1-27 are pending in the application. Claims 1-22 were considered and stand rejected by the Examiner. Applicants cancel claims 9 and 14 without prejudice. The Examiner has withdrawn claims 23-27 from consideration. Applicants believe that no new matter has been introduced.

Restriction/Election:

Restriction to one of the following inventions is required under 35 U.S.C. § 121:

I. Claims 1-22, drawn to processes, classified in Class 438, subclass 778.

II. Claims 23-27, drawn to devices, classified in Class 148, subclass 33.3.

The Examiner asserts that the claims of Group I and Group II are distinct on grounds that the substrate of Group I can be used to produce another materially different product, such as one which does not comprise a semiconductor substrate. Applicants confirm election of the claims Group I, claims 1-22, and have amended claims 23-27 to remove the basis for restriction by removing the term "semiconductor" from claim 23. Withdrawal of the restriction of claims 23-27 is respectfully requested.

Response to Rejections:

Claims 1-22 stand rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 1-22 have been amended to correct the errors noted by the examiner and to more clearly recite aspects of the present invention. Applicants respectfully request withdrawal of the rejection.

Claims 8, 9, 14 and 19 stand objected to under 37 C.F.R. § 1.75(c) as being improper dependent form for failing to further limit the subject matter of a previous claim.

Claims 9 and 14 have been cancelled and claims 8 and 19 have been amended to more clearly recite additional limitations. Applicants respectfully request withdrawal of the objection.

Claims 1-3, 8, 9, 14, 15, 16, 19 and 22 stand rejected under 35 U.S.C. § 102(b) as being anticipated by *Endo et al.* (U.S. Patent No. 4,532,150). The Examiner asserts that *Endo et al.* discloses deposition of SiC by plasma decomposition of methylsilane alone as source of Si and C with helium or argon gas at 50-500C, pressure less than 10 Torr, and 10-100 kW RF power. Applicants respectively traverse this rejection.

Endo et al. discloses deposition of silicon carbide on a substrate surface. *Endo et al.* is silent as to the use of silicon carbide as a barrier layer or etch stop as recited in claims 1 and 15, and claims dependent thereon. *Endo et al.* does not teach, show or suggest depositing a silicon carbide barrier layer on the substrate in the chamber, depositing a metal barrier layer on the silicon carbide layer, and depositing a metal layer over the metal barrier layer. Thus, *Endo et al.* does not teach, show or suggest subject matter recited in claims 1 and 15. Withdrawal of the rejection is respectfully requested.

Claims 4-7, 10-13, 17, 18, 20 and 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Endo et al.* as applied to claims 1-3, 8, 15, 16, 19 and 22 above. The Examiner asserts that the choice of particular temperature pressure, source gas and noble gas flow rates and RF power would have been a matter of routine

optimization within the teachings of the reference. Applicants respectfully traverse this rejection.

Endo et al. is described above. There is no suggestion or motivation in *Endo et al.* of depositing a silicon carbide barrier layer or silicon carbide etch stop. Thus, *Endo et al.* does not teach, show, or suggest the additional aspects of the invention. Additionally, claims 4-7, 10-13, 17, 18, 20 and 21 are dependent from claims 1 and 15, and Applicants respectfully traverse this rejection for the reasons provided for claims 1 and 15. Applicants respectfully request withdrawal of the rejection.

The prior art made of record is noted. However, it is believed that the secondary references are no more pertinent to the Applicants' disclosure than the primary references cited in the office action. Therefore, it is believed that a detailed discussion of the secondary references is not deemed necessary for a full and complete response to this office action. Accordingly, allowance of the claims is respectfully requested.

In conclusion, the references cited by the Examiner, neither alone, nor in combination, teach, show, or suggest the claimed aspects of the invention. Having addressed all issues set out in the office action, Applicants respectfully submit that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,

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APPENDIX

1. (Amended) A method [of forming a silicon carbide barrier layer on] for processing a substrate, comprising:

depositing a silicon carbide barrier layer on the substrate by a method comprising:

[a)] introducing [silicon, carbon,] an alkylsilane and a noble gas into a chamber;

[b)] initiating a plasma in the chamber;

[b)] reacting the [silicon and the carbon] alkylsilane in the presence of the plasma to form silicon carbide; and

[c) depositing a silicon carbide barrier layer on the substrate in the chamber;]

depositing a metal barrier layer on the silicon carbide layer; and

depositing a metal layer over the metal barrier layer.

2. (Amended) [A] The method of claim 1, wherein the [silicon] alkylsilane comprises a [silane] methyl group.

3. (Amended) [A] The method of claim 1, wherein the [silicon and carbon are derived from a common methylsilane, independent of other carbon sources] alkylsilane is trimethylsilane.

4. (Amended) [A] The method of claim 1, [further comprising depositing] wherein the silicon carbide barrier layer is deposited at a temperature of between about 100°C to about 450°C.

5. (Amended) [A] The method of claim 1, [further comprising depositing] wherein the silicon carbide barrier layer is deposited at a temperature of between about 300°C to about 400°C.

6. (Amended) [A] The method of claim 1, [further comprising producing a] wherein the silicon carbide barrier layer [having] has a dielectric constant of [no greater than] about 6 or less.

7. (Amended) [A] The method of claim 1, [further comprising producing a] wherein the silicon carbide barrier layer [having an effective] has a dielectric constant of [no greater than] about 3 or less.

8. (Amended) [A] The method of claim 1, further comprising [producing] depositing a second silicon carbide barrier layer [which is copper diffusion resistant] on the metal layer.

10. (Amended) [A] The method of claim 1, wherein [reacting the silicon and the carbon comprises reacting the silicon and the carbon while maintaining] the silicon carbide barrier layer is deposited at a chamber pressure between about 6 to about 10 Torr.

11. (Twice Amended) [A] The method of claim 1, wherein [reacting the silicon and the carbon comprises reacting the silicon and the carbon while maintaining] the silicon carbide barrier layer is deposited using an RF power supply supplying a power density of about 4.3 to about 10.0 watts per square inch to an anode and cathode in the chamber.

12. (Amended) [A] The method of claim 1, wherein [providing the silicon comprises providing a silane] the silicon carbide barrier layer is deposited with an alkylsilane flow rate of between about 10 to about 1000 sccm and [providing the noble gas comprises providing] a helium or argon flow rate of between about 50 to about 5000 sccm.

13. (Twice Amended) [A] The method of claim 1, wherein [providing the silicon, the carbon, and the noble gas comprises providing] the silicon carbide barrier layer is deposited with a methylsilane flow rate of between about 30 to about 500 sccm, [as the

silicon and carbon source and] a helium or argon gas flow rate of between about 100 to about 2000 sccm, [as the noble gas source and further comprising reacting the silicon and the carbon in] a chamber pressure [range] of about 3 to about 10 Torr, [with] an RF power source supplying a power density of about 4.3 to about 10.0 watts per square inch to an anode and cathode in the chamber, [and] a substrate surface temperature of between about 200°C to about 400°C, and [having] a showerhead to substrate surface spacing of between about 300 to about 600 mils.

15. (Amended) [A] The method [of forming a silicon carbide passivation layer on] for processing a substrate, comprising:

depositing a silicon carbide barrier layer on the substrate by a method comprising:

[a)] introducing [silicon, carbon,] an alkylsilane and a noble gas into a chamber;

[b)] initiating a plasma in the chamber; and

[b)] reacting the [silicon and the carbon] alkylsilane in the presence of the plasma to form silicon carbide; [and]

depositing a first dielectric layer on the silicon carbide layer;

depositing a silicon carbide etch stop having an etch selectivity ratio of at least about 40 to 1 on the first dielectric layer by a method comprising:

introducing an alkylsilane and a noble gas into a chamber;

initiating a plasma in the chamber;

reacting the alkylsilane in the presence of the plasma to form silicon carbide;

patterning the silicon carbide etch stop;

depositing a second dielectric layer;

etching the first dielectric layer and the second dielectric layer to form a feature definition;

depositing a tantalum nitride barrier layer in the feature definition; and

depositing a copper layer over the tantalum nitride layer to fill the feature definition; and

[c)] depositing a silicon carbide passivation layer on the [substrate in the chamber; and] copper layer.

16. (Amended) [A] The method of claim 15, wherein [silicon and carbon comprise a methylsilane] the alkylsilane is trimethylsilane.

17. (Amended) [A] The method of claim 15, [further comprising depositing] wherein the silicon carbide barrier layer is deposited at a temperature of between about 300°C to about 400°C.[.]

18. (Amended) [A] The method of claim 15, wherein [reacting the silicon and the carbon comprises reacting the silicon and the carbon using] the silicon carbide barrier layer is deposited at a chamber pressure between about 6 to about 8 Torr.

19. (Amended) [A] The method of claim 15, [further comprising producing a silicon carbide passivation layer having no substantial penetration of moisture] wherein the silicon carbide passivation layer is deposited by the method for depositing the silicon carbide barrier layer.

20. (Twice Amended) [A] The method of claim 15, wherein [reacting the silicon and the carbon comprises reacting the silicon and the carbon] the silicon carbide barrier layer is deposited using an RF power supply supplying a power density of about 8.6 to about 14.3 watts per square inch to an anode and cathode in the chamber.

21. (Twice Amended) [A] The method of claim 15, wherein [providing the silicon, the carbon, and the noble gas comprises providing] the silicon carbide barrier layer is deposited with a methylsilane flow rate of between about 100 to about 500 sccm, [as the silicon and carbon source and] a helium or argon gas flow rate of between about 1000 to about 2000 sccm, [as the noble gas source and further comprising reacting the silicon and the carbon in] a chamber pressure [range] of about 6 to about 8 Torr, [with] an RF power source supplying a power density of about 8.6 to about 14.3 watts per

square inch to an anode and cathode in the chamber, [and] a substrate surface temperature of between about 200°C to about 400°C, and [having] a showerhead to substrate surface spacing of between about 300 to about 600 mils.

22. (Amended) [A] The method of claim 15, wherein [the silicon and carbon are] the alkylsilane is derived from a common methylsilane[, independent of other carbon sources] selected from the group of methylsilane, dimethylsilane, trimethylsilane, and combinations thereof.

23. (Amended) A substrate having a silicon carbide layer deposited thereon, comprising:

[a)] a [semiconductor] substrate;

[b)] a dielectric layer deposited on the substrate; [and]

[c)] a silicon carbide layer deposited on the dielectric layer and having a dielectric constant of about 6 or less;

a metal barrier layer deposited on the silicon carbide layer; and

a metal layer deposited on the metal barrier layer.

24. (Amended) The substrate of claim 23, wherein the silicon carbide layer [comprises an effective] has a dielectric constant of about 3 or less.

25. (Amended) The substrate of claim 23, wherein the [silicon carbide layer comprises a copper diffusion of about 300 Å or less] metal barrier layer comprises tantalum, tantalum nitride, or combinations thereof.

26. (Amended) The substrate of claim 23, wherein the [silicon carbide layer comprises an etch selectivity ratio of at least about 40 to 1] metal layer comprises copper.

27. (Twice Amended) The substrate of claim 23, wherein the silicon carbide layer is produced by the process of providing [silicon, carbon, and a noble gas comprising

providing] a methylsilane flow rate of between about 30 to about 500 sccm, [as the silicon and carbon source and] a helium or argon gas flow rate of between about 100 to about 2000 sccm, [as the noble gas source and further comprising reacting the silicon and the carbon in] a chamber pressure [range] of about 3 to about 10 Torr, [with] an RF power source supplying a power density of about 4.3 to about 10.0 watts per square inch to an anode and cathode in the chamber, [and] a substrate surface temperature of between about 200°C to about 400°C, and [having] a showerhead to substrate surface spacing of between about 300 to about 600 mils.